eastward of an area of high pressure and lower temperature over the Rocky Mountain States on the 24th–26th, which, occurring simultaneously with the development of the Ontario HIGH, had the effect of segregating the northern portion of the low-pressure into the configuration observed on the 26th.

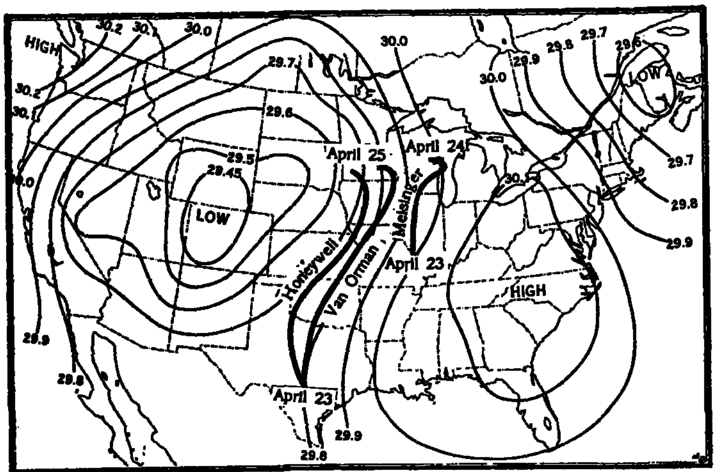

FIG. 1.—Pressure distribution, 8 p. m., 75th meridian time, April 23, 1924

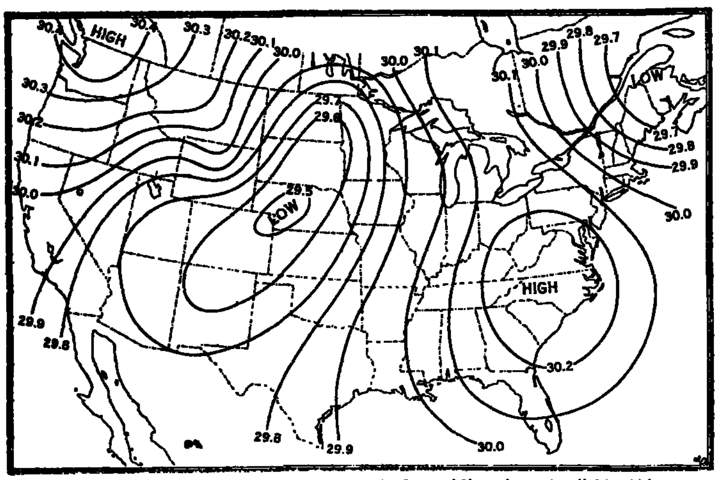

FIG. 2.—Pressure distribution, 8 a. m., 75th meridian time, April 24, 1924

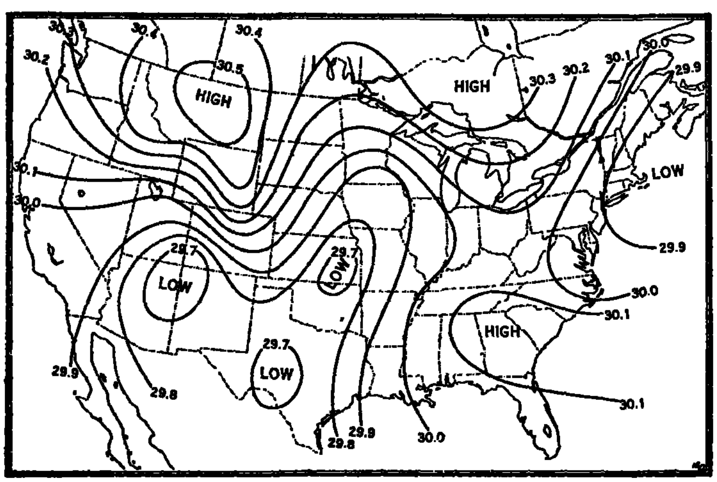

FIG. 3.—Pressure distribution, 8 a. m., 75th meridian time, April 25, 1924

An observation of SSE. wind aloft at 4,000 meters over Drexel on the 25th and at 4,500 meters over Ellendale on the 27th leads to the inference that a normal west-to-east movement of the detached LOW was prevented by the persistency of the Ontario HIGH, of which the SSE. winds aloft were a consequence. A close examination of the isobars on the weather maps from p. m. of the 24th to p. m. of the 26th shows that there was a retardation of the northern limb of the low-pressure trough in the region of the Dakotas and Minnesota during this period that amounted actually to a slight retrogression on the 26th. Further confirmation of this is given by the surface-wind record at Ellendale, where the wind changed from southerly to northerly on the 24th, and veered back to southeasterly on the 26th. It is noteworthy that precipitation did not occur at Ellendale until the wind veered from northwest to directions ranging from north through east to southeast, and that at Drexel precipitation was delayed nearly 20 hours after the wind had changed from south to northwest, and about 8 hours after it had begun at Ellendale. The significance of this is that the precipitation that occurred in the rear of the trough on the 25th and 26th can not all be attributed to the under-running effect of the cold high-pressure area from the northwest. Over southern sections only was it plausibly due to this cause. Over most of the Dakotas and Nebraska it seems more reasonable, from the foregoing facts, that precipitation was due to processes connected with the transport of air from around in front of the LOW.[5] The distinction between the two types of precipitation is often evident by a gap in the shaded area in the rear of the LOW, as is apparent on the a. m. weather map of the 25th.

In connection with the precipitation that occurred east of the low-pressure area, it is interesting to note the changes in temperature that occurred with changing configuration of isobars and, consequently, sources of supply of air. On the 24th at Drexel the temperature was 14.1° C. at 2,000 meters in a SSW. wind; and at Ellendale 15.2° C. at 2,000 meters in a southeast wind, and 6.8° C. at 3,000 meters in a south wind. At Royal Center the temperature was 7.2° C. at 2,000 meters in an east wind on the 26th; and on the 27th, 6.2° C. at 2,000 meters in a SSE. wind, and 1.0° C. at 3,000 meters in a southwest wind. The lower temperatures at Royal Center than at corresponding levels at stations to the west and northwest a few days previously were undoubtedly due to the difference in the source of air. On the 24th the air aloft over Drexel and Ellendale was supplied by the drainage extending far to the south and southwest, in paths approximating the course taken by the balloons. At Royal Center the winds in the lower levels on the 26th and 27th had their origin in the HIGH to the east, while the southwest wind observed at 3,000 meters on the 27th can be traced back in a curved path to the cold HIGH that appeared in the northwest on the 24th. Rain began at Royal Center on the 27th as soon as the wind near the ground changed from easterly to a more southerly component, indicating the building up of an adiabatic gradient between the warm southerly currents near the ground and the cold southwest wind aloft.[6]

551.55

NEW STANDARDS OF ANEMOMETRY

S. P. FERGUSSON and R. N. COVERT

With the approval of the Chief of the Weather Bureau, the authors, in 1921, began a redetermination of the rate of the standard anemometer extending to higher velocities than any attained in earlier tests of the instrument. This work was made possible by the generous cooperation of the aerodynamical laboratory of the Bureau of Standards in providing and operating the two wind tunnels in which

[5] MO. WEATHER REV., January, 1924, 52: 21 (par. (c)).
[6] MO. WEATHER REV., January, 1924, 52: 20 (3d par., 2d. column).

the instruments were tested. During the study of the standard anemometer, Dr. J. Patterson, of the Canadian Meteorological Office, published an investigation showing that a Robinson anemometer having three cups is better than one with four or more; trials of two instruments of this type confirming Patterson's conclusions, our investigation was extended to include the development of a new standard, the design or plan of which should be based upon the most recent studies and accumulated experience. Between April, 1922, and June, 1923, 38 anemometers of different kinds, proportions, and dimensions were tested in the tunnels and on a whirling machine and compared in the natural wind; many of these were modified temporarily to ascertain differences of rate, in steady and variable winds or due to variable friction, etc. In all, including a large number recently studied by Patterson and by Brazier, of France, there are now available measurements and rates of about 100 anemometers, including probably all patterns likely to be needed. From these there has been selected a new standard whose proportions and dimensions were decided upon after conferences with Doctor Patterson and others interested, during which was considered the desirability of a uniform international standard. The same type of anemometer with the same rating has been approved for use in Canada.

In advance of publication of the complete investigation, which will occur at an early date, and in order that the new standards of measurement may come into use as soon as possible, the authors present herein a table of correct values for velocities indicated by the old standard throughout the range of the natural wind, and comparisons of old and new values of the rate and of the old and new instruments.

TABLE 1.—*Correct or true velocities corresponding to velocities indicated by the standard four-cup Robinson anemometer of the Weather Bureau*

[In miles an hour]

Indicated velocity	0	1	2	3	4	5	6	7	8	9
0			2.2	3.2	4.2	5.1	6.0	6.9	7.8	8.6
[1] 10	9.3	10.2	11.2	12.0	12.8	13.5	14.3	15.0	15.7	16.5
20	17.3	18.1	18.9	19.7	20.5	21.3	22.0	22.7	23.4	24.2
30	24.9	25.7	26.4	27.2	28.0	28.7	29.4	30.2	30.9	31.6
[2] 40	32.3	33.1	33.8	34.5	35.2	36.0	36.8	37.5	38.2	38.9
50	39.7	40.5	41.3	42.0	42.7	43.4	44.1	44.9	45.6	46.3
60	47.0	47.8	48.6	49.2	50.0	50.7	51.5	52.2	52.9	53.7
70	54.4	55.1	55.8	56.5	57.2	58.0	58.7	59.4	60.1	60.9
80	61.7	62.4	63.1	63.8	64.5	65.3	66.1	66.9	67.6	68.3
[3] 90	69.1	69.8	70.5	71.3	72.1	72.9	73.6	74.3	75.0	75.7
100	76.5	77.2	78.0	78.7	79.4	80.2	80.9	81.6	82.3	83.1
[4] 110	83.8	84.5	85.2	85.9	86.7	87.5	88.3	89.0	89.7	90.5
120	91.3	92.0	92.7	93.5	94.2	95.0	95.8	96.4	97.1	97.9
130	98.7	99.5	100.2	101.0	101.8	102.6	103.3	104.0	104.7	105.4
140	106.2	107.0	107.8	108.6	109.3	110.1	110.8	111.5	112.2	113.0
150	133.8	114.5	115.2	115.9	116.6	117.4	118.2	119.0	119.7	120.5
160	121.3	122.0	122.7	123.4	124.1	124.8	125.5	126.3	127.1	127.8
170	128.5	129.2	129.9	130.7	131.5	132.3	133.0	133.8	134.5	135.2
[5] 180	135.9	136.6	137.3	138.1	138.9	139.6	140.3	141.1	141.8	142.5
190	143.3	144.0	144.7	145.5	146.2	146.9	147.7	148.4	149.2	149.9
200	150.7									

[1] Average velocity in the United States.
[2] Average standard of gale. Highest standard velocity by whirling machine in 1890, 35 miles an hour.
[3] Average standard of hurricane. Highest velocity by whirling machine in 1913, 67 miles an hour.
[4] Highest velocity usually recorded at exposed stations.
[5] Highest wind at the earth's surface, 186 miles an hour (indicated) on Mount Washington, January, 1876. Highest standard velocity in wind tunnel, 1922, 61 meters a second, or 137 miles an hour.

Tenths of miles or meters in this and the tables following are used only to obtain smooth values and are of no importance in correcting velocities for the reason that two similar instruments exposed near each other will sometimes disagree 5 to 10 per cent or more.

These new values indicate that the rate of the old standard determined in wind tunnels is nearer constant than the rate ascertained previously by means of whirling machines, but a comparison with the table of true velocities published in 1890 [7] shows that the differences between the two are small.

TABLE 2.—*Comparative dimensions and proportions of old and new anemometers*

	Old standard (1860(?)-1924)	New standard (1924)
Diameter of cups	4 inches (102 mm.)	5 inches (127 mm.).
Length of arms	6.72 inches (170.3 mm.)	6.29 inches (159.7 mm.).
Original factor	3	2.50.
Factor for average velocities	2.65	2.50.
Value of 1 rotation:		
Factor 3	10.56 feet (3.22 meters)	9.84 feet (3 meters).
Factor 2.65	8.92 feet (2.72 meters)	
Factor 2.50		8.20 feet (2.50 meters).
Number of rotations of cups for 1 mile of wind:		
Factor 3	500	535.
Factor 2.65	568	
Factor 2.50		642.
Number of rotations of cups for 1 kilometer of wind:		
Factor 3	311	333.
Factor 2.65	353	
Factor 2.50		400.

The mechanisms of the old and new instruments are so nearly alike that the former can be altered to indicate true velocities by equipping it with the cups, spindle, and one gear of the new pattern, at a smaller cost than that of an entirely new anemometer. The dimensions and proportions of the new pattern are such that registration in any scale desired—kilometers, meters, miles, feet, or sixtieths of miles—can be accomplished by simple changes in the wheel work.

TABLE 3.—*True or correct velocities corresponding to velocities indicated by new standard*

In meters a second			In miles an hour		
Indicated	True	Remarks	Indicated	True	Remarks
2	2.1		5	5.1	
5	5.0	Average in America	10	10.0	Average in America.
10	9.8		20	19.6	
15	14.6	Gale.	30	29.1	Gale.
20	19.3		40	38.7	
25	24.0		60	57.8	Hurricane.
30	28.7	Hurricane.	80	76.5	
35	33.4		100	95.2	
40	38.3		120	114.8	
45	43.0		140	134.5	Highest recorded.
50	47.6		160	153.0	
55	52.3		180	172.6	
60	57.1	Highest recorded.	200	191.6	

TABLE 4.—*True velocities corresponding to velocities indicated by old and new standards when the instruments are adjusted to record correctly at average velocities*

IN ENGLISH UNITS

	Miles an hour										
Indicated velocity	5	10	20	30	40	50	60	70	80	90	100
Old standard, factor 2.65	5	10	19	28	37	46	55	64	73	82	91
New standard, factor 2.50	5	10	20	29	39	48	58	67	77	86	95

IN INTERNATIONAL UNITS

	Meters a second										
Indicated velocity	2	5	10	15	20	25	30	35	40	45	50
Old standard, factor 2.65	2	5	9	14	18	23	27	31	35	40	44
New standard, factor 2.50	2	5	10	15	19	24	29	33	38	43	48

The preceding comparisons show that differences between the old and new standards are unimportant or inconspicuous at low or average velocities, but increase at high velocities. When the factor 3 is used, gales of 25 miles an hour or higher indicated by the old standard are

[7] Circular D, second edition, p. 16.

about 22 per cent too high, and when the instrument is adjusted to record correctly at the most frequent or average velocities, by changing the factor to 2.65, its rate is still 6 per cent too high at 25 miles an hour and 9 per cent too high at 100 miles an hour. Velocities indicated by the new standard are about 2 per cent too high at 25 miles an hour and 5 per cent too high at 100 miles an hour; as indicated in the Table 4, when the old standard is properly adjusted and indicates a velocity of 50, the true velocity is 46; when the new standard indicates 50 miles an hour, the true velocity is 48, etc.

It is expected that the new standard will be adopted as soon as instruments now in use can be modified and replaced. A description, including plans of the new anemometer, is in preparation for use by anyone interested in the operation or manufacture of these instruments.

WHY HARDWOODS DO NOT GROW NATURALLY IN THE WEST

By J. A. LARSEN, Forest Examiner

[Excerpts from *The Idaho Forester*, annual, 1922, 4: 28-32]

Unfortunately the beautiful hardwood trees which are native to the Eastern States do not grow naturally in the West. We have here only aspen, cottonwood, small birch, hawthorns, cherry, and alder. On the Pacific coast are oak and maple, but limited largely to lower moist sites such as streams bed and canyons. The general absence of broad leaf trees in the West is most likely due to the difference in precipitation and temperature between the East and West. To be sure, there are other factors which limit the distribution of trees, such as soil acidity, alkalinity, soil and atmospheric moisture, as well as inherent qualities in the plants themselves. Soil acidity and soil moisture or quality of the soil can at best be of significance only within a limited area, and since it has been shown, except for areas near the sea, that atmospheric moisture varies according to the precipitation, it is only a result and, as such, not a controlling factor. Internal structure of leaves and stems, ability to transport much water, injuries by frost, etc., must be looked upon as direct results of the plant's environment rather than factors which control their distribution. There remains, therefore, the factors of temperature and precipitation and the variation and extremes of these worthy of consideration.

Air temperature, though it may not in all cases be a controlling factor, often limits the distribution of trees either by too short, too cold summer weather and frosts during the growing season, or by too great extremes. Experiments have shown that the leaves of trees do not become green in temperatures above 104° F. and do not function below 40° F. Unusually low temperatures may cause root killing, bark and wood splitting, and killing of buds and stems of hardwood.

If the growing season is too short, the species which are introduced from a warmer climate bud out too early in the spring, or have no time to form sufficient wood in the new stems to withstand frost injuries in the fall. If the nights are too cold throughout the summer months, one of the plant foods, sugar, which is not injured by freezing, has not had time to form before the cold weather sets in. The plant food is therefore chiefly in the form of starch, which is damaged by frost.

From the standpoint of water requirement of trees, it is well to note that the structure of the leaves, stems, and wood of trees may render some entirely unsuitable for certain climates, especially in regions characterized by dry summer air and low rainfall. Deciduous trees are able to transport much more water than conifers. Dr. Franz R. von Hohnel, of the Austrian Forest Experiment Station, determined by careful tests over a period of 12 years that 1 acre of oak forest lost by transpiration from 2,227 to 2,672 gallons of water per day during periods of growth. This is equal to 2.9 to 3.9 inches of rainfall per month for the growing season—much more than occurs over the western sections of the United States. Other broad-leaved trees are much like oak in respect to evaporation of water.

An examination of the distribution of hardwoods in the Eastern States shows that their general northern limit follows a line through St. Paul, Minn., to Eau Claire and Sheboygan, Wis.; Grand Rapids, Lansing, and Detroit, Mich. North of this line the forest is predominantly coniferous. From Detroit to central New York an inversion occurs in that the hardwoods are on the north and the conifers to the south. This is evidently due to low land and relatively warm air surrounding the Lakes and the higher land with colder air to the south. From central New York the line goes northeast through western Massachusetts, through Concord, N. H., and Augusta, Me., with conifers on the north and hardwoods to the south. The westward extension of the hardwoods is defined by the Mississippi River from St. Paul to Rock Island, Ill., thence southwestward through Iowa, Kansas, and Oklahoma, irregularly, according to local variations in topography.

In conclusion it may be said that precipitation and atmospheric moisture over the western United States are insufficient for the eastern hardwoods. Air temperature is suitable in most towns and cities and over extensive farming sections. This makes it possible by irrigation or by planting in certain very favorable sites such as moist slopes and aspects sheltered from the driving summer winds, to raise eastern hardwoods in the Pacific Northwest. Except for southern Idaho and the Pacific coast cities, however, the frequent frost which occurs over most of the region during late spring and early fall are a serious drawback, which stunts and kills back the young trees and retards growth on the mature trees.

[Charts showing the mean air temperature and rainfall for different eastern and western cities accompany the article showing the distinction spoken of in the test.]

551.524 : 632

TEMPERATURE SUMMATIONS WITH REFERENCE TO PLANT LIFE

By G. A. PEARSON, Director

[Fort Valley Forest Experiment Station]

Plant investigators are seeking an index of temperature which is expressive of the heat conditions required by plants. The mean temperature generally employed by meteorologists and too often by biologists is misleading when applied in the vegetable world. Plants are far less concerned with the relatively low night temperatures than with the more effective temperatures prevailing during the hours of daylight. For this reason a mean which gives equal wieght to night and day temperatures is a poor measure of the heat available for maintaining the physiological processes involved in plant life. The inadequacy of mean temperature is very evident in the mountain forests of the Southwest, where an extremely high daily range is the rule and where the native vegetation experiences little discomfort from low night temperatures even to the point of frost, but is exceedingly dependent upon heat energy for carrying on photosynthesis.